Property name: Lyngby Port
Property owner: Nordea Ejendomme
Consultants: Rambøll

Total Concept method

Step 3. Follow-up

Building and its use

Year built: 1992
Area: 20 630 m² of heated area
Type of building: Office building

Lyngby Port is an office building in portfolio of a Danish property company Nordea Ejendomme. The building is built in 1992 and divided into 3 building segments; A, B and C at Lyngby Hovedgade 94, 96 and 98 - each of them has main meter installed. Lyngby Port has 7 floors including basement. Segment A has 7 floors, B has 6 floors and C has 5 floors. In the basement an unheated parking area is located. From the center main building three "fingers" stretches out and contains most of the office area. Fingers do not have heated basement. Main "body" or "bow" of the building contains main part of technical rooms and restrooms.
The building consists of cell offices grouped in modules. The intensity of occupancy is around 25m2/pers. The office building Lyngby Port, with several tenants, is being prepared for a new tenant in larger parts of the building. It is expected that there will be a general change from cell offices to more open office areas, supporting a higher number of employees.

Indoor climate

Nordea Ejendomme informed in 2013 that the overall indoor climate is with acceptable air quality, lighting and noise reduction, typical for buildings from that time. During summer period temperature in the offices is often too high. The simulations showed that 6% of all rooms can experience high temperatures during summer. All the rooms are situated in the "Finger" part of the building.

It is concluded that the installed diffusers do not work as designed – supply temperatures under 19˚C causes draught and therefore limits the cooling capacity of the system, which would be increased with lower supply temperatures. The diffusers are mounted incorrectly in the suspended ceiling – the cold air falls down and causes drought among employees.

There has been no earlier assessment of the indoor climate. Indoor climate for the new renovation is specified as class B (operative temperature, draught, air quality) or better according to EN15251.

There was carried out significant upgrade of indoor climate in part C – higher occupation rate and need for refreshment of offices resulted in exchanging the whole ventilation system in the office areas. The main ventilation ducts remained the same. The new ventilation system is VAV with a diffuse supply air. There were also some minor changes in supply air temperature undertaken in building B.

Property owner´s indoor temperature requirements set for the office premises are: winter time +22°C and summer time +23°C.

The status of the building and its technical systems before measures

Building envelope

The building envelope consists of flat roof isolated with roughly 300mm mineral wool all over. Balcony is isolated with 200mm mineral wool.

Most off outer walls are made as masonry with 45mm spacing. Outside is covered with bricks, inside with aggregated concrete and 190mm mineral wool as isolation between. Basement walls towards earth are made with 40 mm concrete and 100 polystyrene plate on the inside of the wall. Basement wall towards non heated area is built the same, but with mineral wool as isolating material instead.

Windows used are 2- and 3-layer thermo windows. The windows are simulated with only air and not argon in the cavity, as it is estimated that most of this gas has evaporated during the last 20 years, which gives a minor increase in the U-value. Most windows are mounted with inner sun screening.

Basement flooring is constructed in concrete. 200 mm expanded clay aggregate towards the dirt.

Heating

The main heating system consists of radiators in all heated rooms. Basement under the building (storage, bath, etc.) is treated as heated area.

For heating two boilers from DANSTOKER are installed. It is evaluated that efficiency of the boilers is 84%.

Heat distribution piping is done with a two-string supply system, going from basement to roof. Technical rooms are placed in the unheated parking basement, so part of the distribution is through basement. Mixing plants are placed in technical rooms in basement and in roof houses A and B.

EMO-repport states that domestic cold water use is 1800 m³ pr. year. It is assumed that 30 % of this corresponding to 540 m³ pr. year is domestic hot water.

Ventilation

The buildings ventilation system is divided into 6 VAV- systems with heat recovery (71-74%) and 6 exhaust systems with no heat recovery. The 6 exhaust systems; 1 for cooling technical room; 2 for kitchens; 1 for labs and printer rooms; 1 for fume cupboard. All systems are approximately 23 years old and in good condition. It is though evaluated that efficiency of fans and heat recovery has dropped by approximately 10%.

The air distribution works with a variable flow rate CTS-system. Constant air pressure in air ducts. Ducts are approximately same age and condition as ventilation system.

There is exhaust ventilation in parking basement.

Cooling

The cooling system consists of 2 compressor-/water cooling-systems with 6 cooling units with an average COP=2.5 and is in very poor condition. Chillers are used for distribution. There have been no changes since construction. Cooling central is placed in basement parking area. Mixing plants are placed in basement C and roof houses A and B. The building is cooled through the ventilation air.

Lighting

The lighting systems vary, depending on the location in the building and it is as follows:

- Staircases (energy saving light bulbs with PIR sensors)
- Corridors (energy saving light bulbs, no sensors)
- Canteen (halogen spotlights, no sensors)

- Offices:
  - Bank (compact fluorescent light and energy saving bulbs, no sensors)
  - Court (compact fluorescent light and energy saving bulbs, no sensors)
  - Other offices (compact fluorescent light; 216W/module)

Equipment

The equipment in the building is typical office equipment and corresponds to around 100W/pers. There is no server room or kitchen in the building.

Control and monitoring system(s)

Nordea Ejendomme informs that BMS though does not work correctly and needs an upgrade in connection with the renovation.
Because of a very limited temperature deadband for ventilation system and draught problems there is a high risk for simultaneous heating and cooling throughout the year.

Energy and resource use before measures

The calibrated model showed correspondence between measurements and simulation model. However the assumptions do not reflect future use, with a higher person load in section A and C of the building. This is based on 20% more people in the A section of the building. The B section is adapted with same load per square meter. The result of the higher person loads is that several rooms will have higher operative temperatures than existing fit-out. It is therefore necessary to lower ventilation inlet temperature from 19˚C to designed 17˚C. This change increases energy consumption in comparison to existing building.
The baseline model is therefore carried out with higher person load and minimum supply temperature 17˚C.

Specific energy use before measures	131 kWh/m²,Year
Whereas	
Heat energy	77 kWh/m²,Year
Electricity for building operation (cooling, ventilation, lighting in parking)	25 kWh/m²,Year
Electricity for tenants	29 kWh/m²,Year

Identified energy saving measures (Step 1)

The following measures were identified:

1. Conversion of natural gas boilers to district heating
2. Replacing existing cooling machine
3. Isolating ventilation ducts in the shafts
4. Replacing fans in ventilation units.
5. Optimization of BMS system, including heating, lighting, ventilation and solar shading.
6. Lighting sensors in toilets, corridors and technical rooms.
7. Photovoltaic
8. Replacing existing windows and solar shading

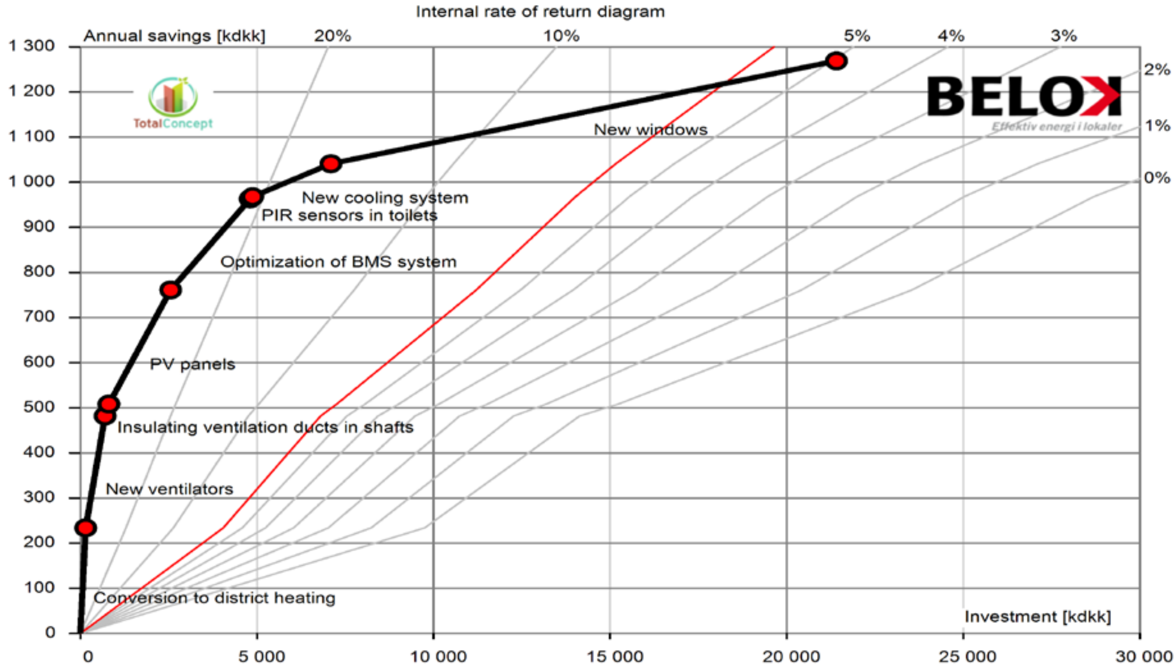
Following measures are not seen as potential energy saving measures

- Exchange of pumps as described in earlier energy certificate was performed last year, and therefore not a potential energy saving measure.
- Installed lighting effect is already rather low, and is not included as a potential energy saving measure.

Summary of the measures in the action package

MEASURES PLANNED IN STEP 1

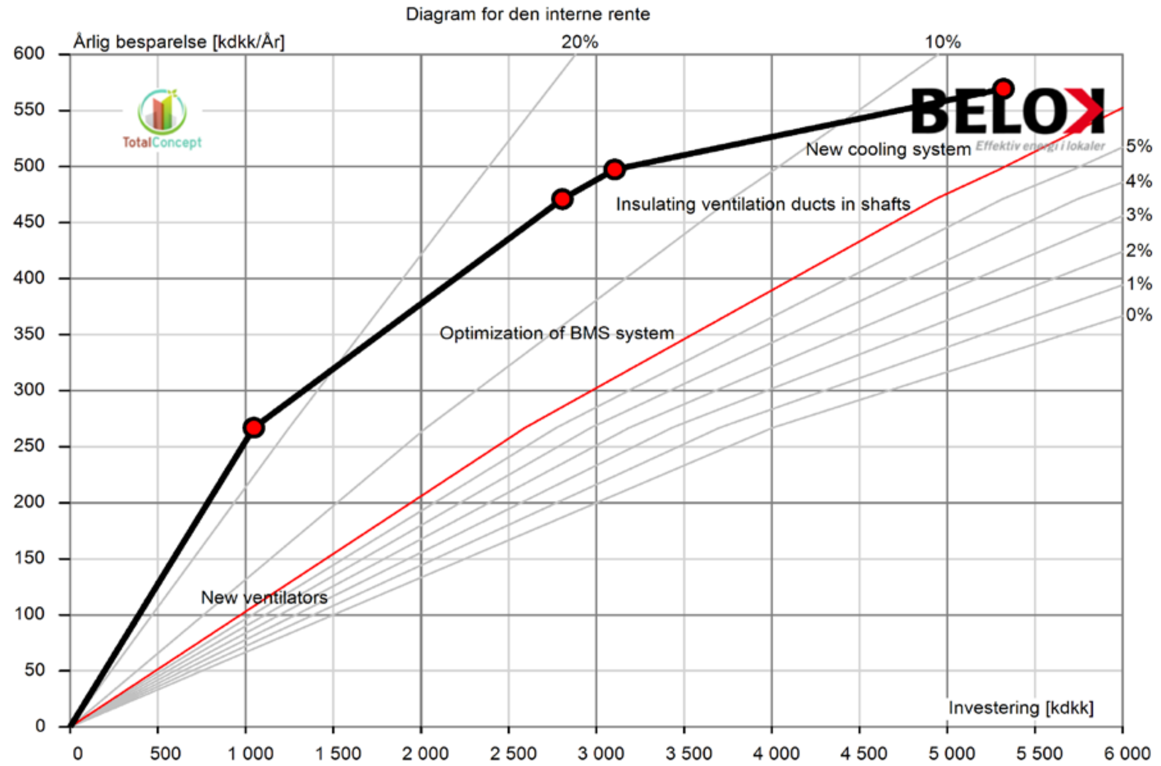
Total measured energy use before renovations was 2549 MWh/yr (including tenants' electricity). Due to planned tenant adjustments of indoor climate and number of occupants the energy use of the building was estimated to increase to about 2703 MWh/ yr. This was set as a new baseline for energy efficiency measures. The proposed action package in Step 1 contained 7 energy saving measures, which were planned to be carried out as part of the upcoming renovation for the tenant adjustments as shown on the graph below.



Step 1 of the Total Concept method (forming an action package) was carried out in the buildings in 2014 and the proposed measures were implemented (Step 2) in 2015-2016.

MEASURES CARRIED OUT IN STEP 2

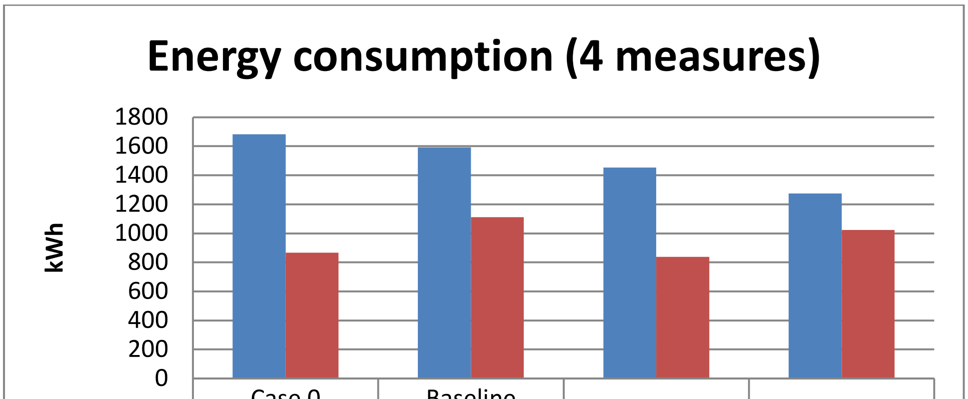
The proposed action package in Step 1 contained 7 energy saving measures, which were planned to be carried out but eventually four measures were carried out in Step 2. Conversion to district heating will be first implemented in spring 2017 (problems with cables in the ground from light rail located nearby). The solar panels installation is planned to be first implemented in spring 2017. Profitability outcomes' of the adjusted action package are presented on an internal rate of return diagram below.



The action package carried out in Step 2 the total building energy use was estimated to be with the internal rate of return about 8 %.

Summary of the outcome of measurement and follow-up in Step 3

The renovation finished entirely in 2016 only for section A and B of the building. Furthermore section A remained empty in 2016. The works in section C finished in October 2016. The presented results are therefore only valid for section B (and partly section C) and they were scaled for section A and C. The scaling of the results from section B is based on assumption that the energy decrease would be similar in section A and C when fully occupied. The figure below presents the measurement outcomes in Step 3 compared to estimated baseline in Step 1 and calculated values in Step 2.



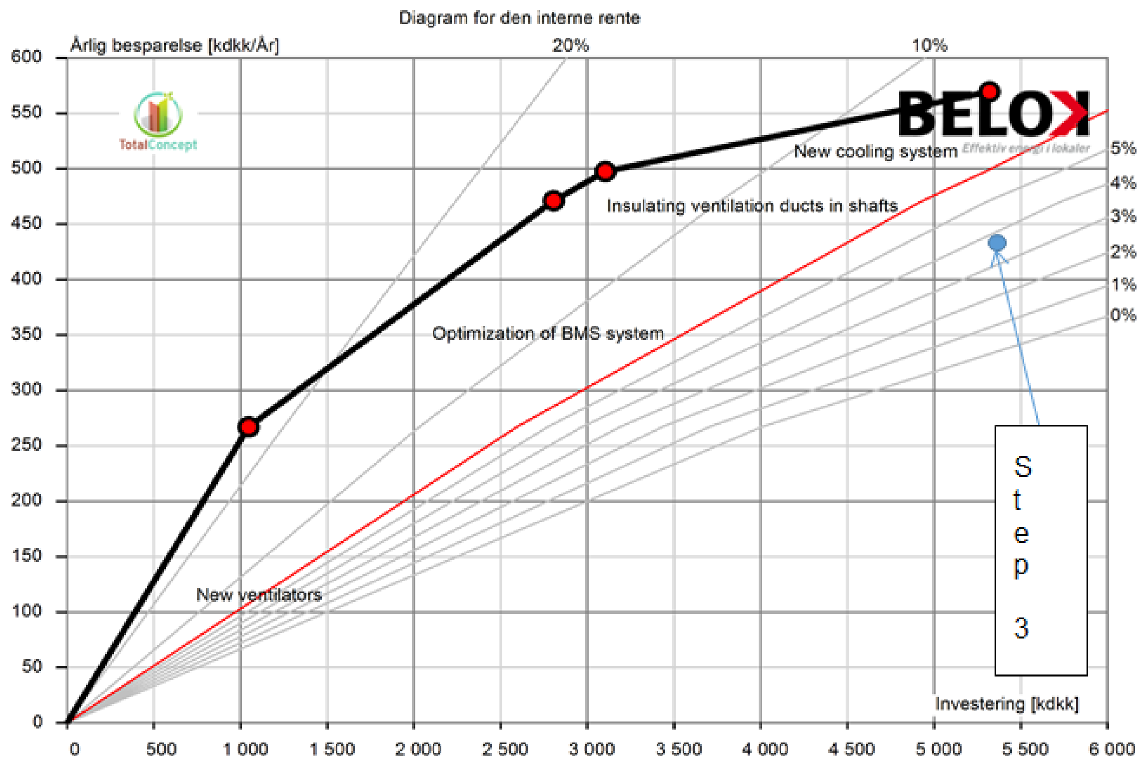
	Case 0 (exisiting 2013)	Baseline (before package)	Step 2 (calculations)	Step 3 (after renovation)
Heating	1683	1592	1452	1274
Electricity	866	1111	838	1022

Energy savings are based on the new baseline for the energy performance of the building.

The total heat energy use after renovations is about 1274 MWh/ per year (decrease by 19% comparing to the baseline). The estimation in Step 2 was about 1452 MWh/m2 per year. The total heat energy use after renovations is about 1022 MWh/ per year (decrease by 21% of the common energy and 8% of the whole energy comparing to the baseline). The estimation in Step 2 was about 838 MWh/m2 per year. The deviation can come from lack of valid measurements for section A and C. The missing saving is due to higher electricity use for ventilators. There are 2 probable reasons for this: higher occupation rates are handled with more air instead of lower temperature (priority programmed in BMS) as well as higher pressure loss in the ventilation units then originally calculated. The high pressure loss in the ventilation units will be reduced by increasing size of openings after ventilators as well as removing unnecessary bendings after the air handling units. This is planned for February- March 2017 (inclusive measurements before and after).

The calibration of the systems is still needed and data for the full year of measurements should be analysed. Moreover the tenant for section B (court) is characterized by fluctuations in use of the building (number of persons, operation time). The results show unexpected increase in heating demand in December 2016 comparing to 2013. To validate the results the internal gain, operation hours, set points and climate data have to be compared. The results for electricity show even more fluctuations – and it is suggested that the electricity data will be followed precisely for the next months.. The more steady office environment would give more reliable results.

The action package carried out in Step 2 the total building energy use was estimated to be with the internal rate of return about 8 %. The measured/scaled outcomes in Step 3 show the savings for now with the internal rate of return 4 %.



The result is only informative as there are still some unclarified issues. After solving the problem with high pressure loss in the ventilation system the internal rate of return will be higher.